A CASE OF VISION ACQUIRED
IN ADULT LIFE.

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M662

Psychol. Rev., Monograph Supplement,
6, 1905, 102-118.

A CASE OF VISION ACQUIRED IN ADULT LIFE.

BY JAMES BURT MINER, PH.D.

The opportunity of studying a case of complete congenital cataracts in which vision was not acquired until adult life is seldom given to a laboratory. About twenty cases of acquired vision have been reported in the psychological literature of Europe; in all except a few of these, sight was restored early in life.[1] So far as I can discover, there has been no psychological investigation of a congenital cataract case in this country. The present Iowa case, moreover, seems to be the first attempt to utilize the modern laboratory equipment for testing systematically and quantitatively the senses and the learning process of a blind person who has been made to see. The young woman here reported was blind from birth by reason of complete cataracts in both eyes. She was operated on when she was 22 years of age.

In order that there may be no misunderstanding, it should be stated that persons having complete cataracts can distinguish light and darkness. In the opinion of Dr. Ware, who reported two cases to the Royal Society of England, patients with cataracts 'are never so totally deprived of sight as to be unable to distinguish colors.'[2] In the famous Chesselden case the boy could distinguish scarlet previous to the operation.[3] These individuals are 'blind' in the popular and medical acceptation of the word; they make no use of their eyes in their daily work.

[1] W. Preyer, *The Mind of the Child*, 1889, Vol. II., appendix C., excerpts from cases of Chesselden, Ware, Home, Wardrop, and Franz; references also to cases of Hirschberg, von Hippel, and Dufour.

B. Bourdon, *La perception visuelle de l'espace*, Paris, 1902, Chap. XIII., refers at length to the above cases and also those of Albertotti, Uhthoff, and Vurpas and Eggli.

R. Latta, 'Notes on a Case of Successful Operation for Congenital Cataract in an Adult,' *British Jour. of Psych.*, 1904, I., 135–150.

The Medical Index Catalogue of the Surgeon General's Office, U. S. Army, Second Series, 1898, congenital cataracts.

[2] Preyer, *loc. cit.*, p. 293.

[3] Preyer, *loc. cit.*, p. 286.

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It seems safe to say that no person absolutely blind from birth has ever acquired sight. If the nervous mechanism were intact, a blow on the eye would give the sensation of light. With cataracts, there seems to be no reason why a decided difference in the intensity of light cannot be distinguished; some notion of the distance of objects would be acquired by this means. If there is a distinction between light and darkness, when an object comes between a patient's eyes and the sun he should be able to get some sort of visual idea of diffused outline. Previous to the removal of the cataracts he might, therefore, associate a visual impression with an accompanying movement. This would give some degree of visual space perception. Franz's patient could distinguish a vertical from a horizontal line on the first trial after the operation. It seems as if this would always be possible. The patient's vision is in much the same condition as if he had always been compelled to look through a glass of milk. Not only is the transparency of the lens affected, but the refraction is also disturbed. Previous cases seem to have established the fact that after the removal of the lens the patient is not able to recognise objects with which he was perfectly familar by touch. Objects also appear larger than they did to touch; solids look like surfaces. In the points above mentioned the present case corroborates the conclusions of previous observers.

History of the Case.

In this paper I can only attempt a brief preliminary report of the case which came under observation recently at this laboratory. The young woman, Miss W., besides having unusual natural ability for her age, brought to her new visual experience all the training of an excellent high school course. She is a graduate of the State School for the Blind at Vinton, Iowa. Moreover, she is a splendid introspector, as blind people often are. Having been inclined for many years, by reason of her blindness, to watch her own mental states with considerable care, she has developed a remarkably keen power of observing and describing her psychical experiences. One incident will illustrate this. When her retinal color fields were to be mapped

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with a campimeter, one of her eyes being covered, she was told to fix her other eye on a certain point and, holding the eye still, to tell what happened as a disk of color was drawn slowly away from the fixation point. Usually the observer will note, when the disk reaches a certain place (the limit of the field), that it disappears or changes into a different color. She, however, besides noting these facts, made the additional remark that 'just before the color leaves, it seems to grow much brighter; it almost glows.' This change in intensity is one which a skilled introspector often has difficulty in observing. Miss W. would rank well with introspectors of many years' training. Another circumstance made Miss W. particularly valuable for the series of experiments which we conducted. Her eyes had fully recovered from the operations and had been so strengthened by use that she could carry out extended tests without fatigue. She had been fitted with both far and near spectacles, so that she was able to find her way about, and could even read print with some facility.

The first successful operation on Miss W.'s eyes was performed at the School for the Blind in March, 1902, by the surgeon for the school, Dr. Lee Wallace Dean, who is also professor of ophthalmology in the medical college of the University of Iowa. The operation was that of needling, or discission of the lens of the right eye. A year later a successful discission of the lens of the left eye removed that also by absorption. As it was not until November, 1904, that we had the opportunity to study her case, she had already acquired much knowledge of the visual world. Since the first few days of sight have been so completely reported by observers of other cases, this delay was found not to be serious. Miss W. was still completely naïve to many of the normal visual experiences of an adult. She had never looked through a stereoscope, opera glass, field glass, or telescope. She had never used both eyes together enough to find out any differences between monocular and binocular vision. She had not yet learned to translate her visual images into terms of movement with any degree of success, except in case of the most simple forms and numbers or with common objects of her previous touch experience. She

knew practically nothing about drawings or pictures. She had not even learned to identify people by their faces; those whom she thought she knew by their features were her mother, father, sister, a teacher at the school, and the nurse who was with her during the operations. Although I worked with her every day for over a month and she saw Dr. Dean often, I believe she cannot yet recognize either of us by sight.

There seems to be no doubt as to the congenital character of Miss W.'s blindness. Dr. Dean states that the lenses were completely cataractous at the time they were removed. He says: 'I am confident that their extent had not changed from the condition at birth.' The young woman's father says that a peculiar twitching of the child's eyes was noticed soon after birth, but the family did not realize that she was blind until she was about four months old. The family physician states that, so far as he can remember, he diagnosed congenital cataracts at about that age. It should be stated that the reason why the eyes were not operated on earlier was that the parents had been wrongly advised by an occulist whom they consulted when she was a child.

Early in her life Miss W. seems to have amused herself by trying to follow the heavy black letters in a primer. Her practice in this respect at first seems to indicate that she may have seen slightly. A further consideration of the facts as she remembers them indicates that it was only playing at reading. As she relates the experience she says she could hold a large letter close to the corner of her eye and by moving the book she could tell when she left the black of the letter. Keeping the eye still and carrying the printed letter in different directions she determined what the letter was by the movements of her arms. It may be possible that this process was aided when she was young by light reaching the periphery of her retina between the iris and lens. It is curious that the left eye which she used in this practice shows a retina which has been atrophied for nearly a third of the distance from the periphery. In Miss W.'s case there was always the ability to distinguish white from black, and as near as we can determine by questions, she could also distinguish red, blue and yellow. These colors were, however,

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so much duller that she hardly recognized them after the operation. She says that when she first saw her clothing it seemed to her as if she had 'an entirely new wardrobe,' the colors were so unexpectedly bright and different.

The general plan of the investigation was to first arrange a series of tests for touch, hearing, and sight by which measurements could be made of the lower, upper, and discrimination thresholds. The tests were to be standardized so that they might be used subsequently in any other laboratory in similar cases. They were also to be the basis for comparison with records from a group of normal individuals, to determine the effect of the disuse of the eyes not only upon vision, but on the other senses. Unfortunately, as yet there has not been time to prepare the group of normal records for comparison, so that the conclusions expressed in this paper must be largely tentative in nature. Another series of tests was planned to investigate her process of learning in the new field of vision. This touched a long list of problems of special interest to education, psychology and philosophy.

Tests of the Senses.

There is a popular idea that the loss of sight in a blind person is compensated for by greater keenness in the other senses. The present case offered a chance to determine how far this conclusion is supported by the facts. The tests on hearing show that Miss W.'s range of pitch is very wide. As tested by the Koenig bars and the Galton whistle, Miss W.'s upper limit is approximately 50,000 vibrations per second, and a rough test of her lower limit indicates that it is slightly below 16. Although she has this wide range of tone sensations, we found that her discrimination between simple tones was not unusually keen. With the tuning forks she distinguished, nine times out of ten, a difference of eight vibrations from the international a′ (435 vibrations). Tests with the audiometer also indicated that she was not far from the average in her discrimination and liminal thresholds for sound. Her localization ability was tested by Mr. Starch with the Seashore sound perimeter.[1] The most

[1] Daniel Starch, 'Perimetry of the Localization of Sound,' *Univ. of Iowa Studies in Psych.*, 1905, IV., 1.

noticeable factor here was an inordinate tendency to move her head in order to localize the sound.

With the sense of touch, the pith-ball test showed no peculiar sensitivity for passive touch. The æsthesiometer tests on the tip of the forefinger were not numerous enough to be accurately stated, but they indicated that two points could be distinguished when 1½ mm. apart. Active touch was tested by a more satisfactory method. A piece of very fine steel wire (No. 35 B. & S.), 7 cm. long, was laid on a plate of glass. It was then covered with 43 sheets of letter paper (Brother Jonathan Bond, 17 × 22, 20 lbs. to the ream, 500 count). Miss W. determined correctly ten times in succession whether the wire was in a vertical or horizontal position. With 44 sheets she was right eight times out of ten. It is impossible as yet to give normal records for comparison.

So far as these tests on hearing and touch go, it seems to me that they give good evidence that training has improved her active touch and probably increased her interest in overtones to such an extent as to somewhat enlarge the range of pitch. She recognizes people entirely by their voices. For this purpose the noticing of overtones is more important than fine discrimination of simple tones. I would conclude, therefore, that the effects of training in active touch and hearing are evident, but there is little evidence that the native untrained capacity of other senses than sight has been increased. We may suppose that persons who have always seen could, by similar training from birth, make equally good records in hearing and touch.

In the examination of Miss W.'s vision, it was found that, without spectacles, she could read letters on the Snellen charts at 20 cm. distance which normally are read at 500 cm. Considering the fact that she has no lenses in her eyes, this may be regarded excellent. Dr. Dean has provided her with distance glasses having a spherical correction of + 10 diopters. According to his record her vision with these spectacles is 6/36; this means that she reads at a distance of six meters what she ought to read with normal eyes at a distance of 36 meters. Her reading glasses have lenses of + 13 diopters. With these

I found that she could read much smaller than the usual newspaper type (Snellen's D. 1.2) when she held it close to her eye. The campimeter and ophthalmoscope show that about one third of the outer part of the left retina is useless. Otherwise the relations of the visual area and color fields seem normal. Aside from the lack of lenses, Miss W.'s vision is also affected by the constant twitching of her eyes (nystagmus) and by cross-eyedness (concomitant convergent strabismus). These often accompany congenital blindness. There is some indication that the strabismus may be partially overcome, as will be explained in the discussion of binocular vision. Tested with prisms, the horizontal convergence cannot be corrected by a twenty-degree prism. A prism of from 4 to 6 degrees is necessary to correct the vertical disturbance.

The color vision of Miss W., it may be safely said, is decidedly above the average. She can detect color in solutions that are perfectly transparent to those of us who have been working with her in the laboratory. She can also discriminate differences in tint which are considerably below our threshold. In looking at the spectrum, she can apparently see ultra-violet which is beyond the usual field of view. The interpretation of her observations of the spectrum is a matter of some perplexity, so that I would not be sure of the present record without further check experiments. Preliminary work with the spectroscope indicates that her spectrum is about one fifth longer than the average of ten students. The length is added to the violet end. I suspect that this difference is largely due to a difference of interest in the test. In the examination of the color threshold and discrimination, the Lovibond tintometer was arranged for standard daylight, which was regulated and measured photometrically each day. With the intensity of light which was used, she was able to discriminate 16 times out of 20 a difference in red amounting, in the units of the instrument, to 1 in 700. Tested also for the threshold of color, she was able to name correctly red, green, blue and yellow nine times out of ten when the slides .2 were used. In the slides supplied with the instrument, .1 is the only lighter tint that is furnished. Two students who were tested became insensitive to color at slides .5 and 1.0;

they failed to discriminate reds, under the same conditions as Miss W. worked, when the difference in shade was 1 to 20. Another series of tests was started to check these results, using standard solutions of blue and red instead of the Lovibond tinted glass slides. As yet I have no records for comparison. The reaction time for discriminating white, black, red, green, blue, yellow and orange has been obtained. The examination of Miss W.'s perception of color contrast and after-images shows that in these respects she is practically like other individuals.

These facts of color vision seem to me to have some importance for biology. Twenty-two years of almost complete disuse of the retinas have caused no degeneration of the color process so far as can be determined. The tests point rather to a color vision beyond that of the normal adult. This seems somewhat contrary to what might be expected. The fact may be explained in several ways. It is possible that further tests on other adults may show normal individuals who can reach Miss W.'s record in color discrimination. Should equal records be made by any other adult, I should be inclined to believe that the pronounced difference manifested between Miss W.'s color vision and that of us in the laboratory is a difference due to her decidedly greater fascination for color. On the other hand, if the normal adult cannot equal her record, we seem to have a suggestion that the color process of the retina may degenerate with use. On account of the difficulty of interesting children in the tests, negative records made on those who are younger would hardly determine this point. The fact that there are no lenses in Miss W.'s eyes is also to be borne in mind; this may give her a clearer vision of color. So far as the evidence at present stands we seem to have several possible conclusions. The lens may obstruct our view of color, the color process may deteriorate with age, or a phenomenal interest in color may increase our liminal and differential sensitivity for light far above the average.

Apart from her remarkable sensibility to color, one of the most surprising facts thus far discovered is that Miss W. sees black objects larger than white objects of the same size. This reverses the usual illusion of irradiation. Measurement of the illusion shows that a white isosceles triangle with a base of 5 cm.

and altitude of 8 cm. appears to Miss W. as equal to a black triangle of 7 cm. altitude. The average variation from the altitude 7 is only .2 cm. for 16 trials. Using a special form of the method of right and wrong cases, a white square of approximately 5.5 cm. was selected as equal to a black square 5 cm. on a side. One of the most interesting features of this anomaly occurs with the illusions which are thought to depend on irradiation, the Münsterberg figure of the shifted checkerboard and the kindegarten pattern which is related to it.[1] Miss W. says that she is able in both these illusions to perceive the lines tilted in either direction with about equal facility, although at first she saw the checkerboard illusion reversed.

It is difficult to say what may be the explanation of this curious contraction of the white field or expansion of the black. I have suggested that it seems to indicate that the illusion here depends more on a brain process than on a retinal process, that it is connected with our general interest in bright things and disregard of dark objects. In Miss W.'s case the reversal of the white and black square illusion would be explained by the fact that during her twenty-two years of blindness it was really black objects which were the most important in her experience. When something dark came between her and the light, it was an obstacle to be avoided. The normal child, on the contrary, always actively demands what is bright and is continually interested in the more intense colors. It might be well to measure the illusion in persons suffering from melancholia, among whom darker colors are said to be more appreciated. The hypothesis that the central process is most important in Miss W.'s experience of this illusion is corroborated by the fact that she is able to reverse the kindergarten pattern. I believe that the irradiation illusions will acquire their usual form with her after more experience; I even found some indications of this during her stay at the university. The facts seem to establish that the peripheral diffusion of the light stimulus, if it occurs, is easily outweighed by the central condition. It is possible that irradiation is always central rather than retinal.

Aside from irradiation, Miss W. seems to obtain the common

[1] A. H. Pierce, *Studies in Space Perception*, New York, 1901, p. 213.

visual illusions normally, unless it be the illusions of interrupted space and those dependent upon perspective. In these latter cases her introspections at different times are in conflict. The Müller-Lyer and the cross illusions were measured for comparison between Miss W. and other individuals. I found no reason to suspect that the results with the Zöllner and Poggendorf figures were any different for Miss W. than for others. Records of the reproduction of horizontal lines by sight and by touch were obtained for comparison. They afford some evidence as to the relative value of visual and tactual space.

Investigation of the Learning Process.

Besides testing Miss W.'s senses of vision, hearing, and touch, the main effort has been to study the process by which she learns to interpret what she sees. Undoubtedly the most fascinating work along this line was in connection with the development of binocular vision. It is a prevalent belief among physicians that the ability to see objects single when using both eyes must be acquired early in life or not at all. It has been suggested that the necessary association paths in the brain cannot be developed in adult life. The occulists point to many cases where a condition of crossed eyes has been corrected in adults, by operations on the eye muscles, and yet single binocular vision has not been attained.[1] In such cases the individual neglects the image of one eye. Miss W. was in much the same condition as any cross-eyed person, except that she had used her eyes for only two years. Some idea of the progress which was made in the few weeks during which she was at the laboratory may be gathered from the following incidents.

While she was still naïve on this subject, I asked her to look through two small tubes, one held before each eye in such a manner that, if she desired, she could look with both eyes at the same object without moving the tubes. Under these conditions and looking at a single cone standing on the table, she said: 'I see two cones, one with the right eye and the other with the left.' She was quite emphatic about seeing two cones

[1] The question is in dispute, Landolt gives instances in which he trained patients, who were formerly cross-eyed, to get single binocular vision. Norris and Oliver, *System of Diseases of the Eye*, Philadelphia, 1900, IV., 151.

on the table. This was undoubtedly the usual way in which she interpreted the images from her two retinas.

The same effect was obtained in even a more striking way when Miss W. was provided with spectacles having differently colored glasses. Asked to describe how a large white surface appeared through the spectacles, she said: "Why, I see a large sheet of red cardboard with my right eye and a sheet of green cardboard with my left eye. They are both in the same place and I am just as sure that I see them both at the same time as I am that I am standing here." When carefully questioned if one card was not seen after the other or behind the other, or if one part of the surface was not red and the rest green, she persisted in her first statement. She said that she could not understand how there could be two different surfaces in the same place at once but that was the way she saw them. Under the most careful experiments with gelatines of unknown color before her eyes and instantaneous exposures by an electric spark (conditions under which others in the laboratory were able to see but one color, on account of the tendency to retinal rivalry), Miss W. still maintained her perception of two surfaces of full size and of different colors, not overlying each other in any way.

If the psychologist should say that probably Miss W. did see two surfaces in the same place at the same time, we might be somewhat confounded by the mathematical axiom. However, it seems to me that we are forced to admit that she really did see two things in the same place at the same time. Furthermore, I am inclined to think that this may be the usual impression in childhood under like conditions. Moreover, there may be two moons for the child. Our later interpretation of what we see is a matter of education. We learn, of course, that there are not two objects, so we neglect the doubling of our eyes; or we disregard the image of one eye thus developing our phenomenon of retinal rivalry. It is possible that this rivalry of retinal images arises somewhat late in the child's life, and is only gained after the visual experience is tested by touch. From a subjective point of view, we may be quite confident that, for Miss W. at least, two differently colored surfaces were seen in the same place at the same time, and, also, that she naïvely believed that she saw two cones when there was only one.

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Under these circumstances the experiences of Miss W. with the ordinary stereoscope were exceedingly interesting and suggestive. As soon as it was discovered that she had never looked through a stereoscope, every precaution was taken to leave her completely naïve as to the effect of the instrument. The series of stereoscopic views used by occulists and the imported Martius-Matzdorff set were employed in the experiments. After some practice, it became apparent that there were hints of single binocular vision. At times she would say that she saw one figure, instead of stating that she saw one figure with her right eye and another with her left. The latter interpretation, however, continued when there was any marked difference between the two parts of the stereoscopic view. In a few cases I believe that I succeeded in getting her to combine views in which the picture before each eye had other differences than those necessary for giving relief. She thought also that she finally succeeded in seeing the sheen which results from combining black and white.

Before the experiments stopped, she had so far progressed with single binocular vision that she had no difficulty in seeing the ordinary stereoscopic picture in full relief, and she readily picked out views with no relief, and with a pseudoscopic effect. The usual precautions were taken to make sure that she was not merely saying that she saw single with both eyes, if she was unconsciously neglecting the image of one eye. As checks against this possibility, the partition between the prisms was removed, and she noted the three pictures visible; one side of the slide was covered, and she noted the shifting of the picture from the center to the side. Finally, accurate tests were made upon her ability to discriminate distances with both eyes compared with her monocular ability. Different sized balls were hung at varying distances from her. Using only one eye she judged them to be at the same distance when one was 15 cm. farther away. But the difference between the two balls was narrowed down to 6 cm. when both eyes were converged on one ball and then on the other. Her error was thus cut in half by using both eyes together. On account of her long standing strabismus these tests were extremely fatiguing. At best she was able to

keep her eyes converged only a few minutes at a time. The improvement was so marked in the short time she was being trained, however, that her ambition to overcome her cross-eyedness does not seem entirely hopeless.

The introduction of Miss W. to a clearly outlined view of nature in perspective, which she first had in looking through the opera glass, afforded another series of introspections which mean much for the theory of space. The limits of the present article do not permit publishing the dialogues between Miss W. and the experimenter over this experience as it developed. They covered inquiries as to how she knew the picture was real, the interpretation of objects seen in unnatural size with the glass reversed, etc. Her æsthetic preference for blurred over clear outlines in certain circumstances is an interesting contribution to the defense of impressionistic art. These experiments were followed by an attempt to find out how she learned what perspective in pictures meant. Beginning with simple line drawings, she was gradually led to the interpretation of complex scenes and even cartoons. The latter still distress her very much. 'Why do they make all the people look so ugly?' and 'What are all those lines on their faces?' were some of her comments about newspaper drawings. Considerable material has been gathered which may give helpful hints for teaching drawing. The child every day lives through modified forms of the experiences which Miss W. had in the laboratory.

From the psychological point of view, it was important to determine whether the development of her conceptions of form, solidity, distance, and number always required the translation of visual images into movement and touch terms. Her all-powerful impulse to explain anything new by referring it at once to the language of her sightless experience, makes the interpretation of her visual consciousness very difficult. By showing some novel figure to Miss W. for a few hundredths of a second through an exposure shutter, it was possible to study how she perceived, imaged, and interpreted it. After repeating the exposure many times, her method of counting the sides of a figure could be observed. With practice she was able to obtain an indistinct image and then count the sides after the picture had been withdrawn, although she could not count the sides

during the time of the exposure. Kinæsthetic sensations undoubtedly play a most important part in her conceptions of number and space. When Miss W. was directed to count the sides of a hexagon, but to shut her eyes the instant she caught herself making any movement, and then begin again, I found that she was not sure of the number of sides after observing the figure a total of five minutes. She would not look at it continuously more than 10 to 20 seconds without beginning to count its sides by using some muscular contraction to mark each corner as she changed her attention from one part of the visual impression to another. She would tap with her fingers or foot, press her teeth together or her tongue against her teeth, move her head, regulate her breathing, or even slightly wink at each corner, in order to register that as number one before passing to the next. On account of this irresistible impulse to move and to touch, it may be doubted whether a blind person who acquires vision is a suitable subject to decide whether visual images have spatial meaning apart from movement. In no case, I believe, has Miss W. ever questioned the extension characteristic of her visual sensations. So far as the experiments went, they corroborated the current hypothesis that shape and number get their meaning from touch and movement.

Many instances might be cited to show the difficulty Miss W. has in interpreting her visual experience. For a long time, shadows were quite troublesome to her. They seemed like real objects. Once in a while she still catches herself walking around a shadow on the sidewalk, or stepping over it as she would any obstacle in her path. Dishes were upset at the table because she could not judge their position. A cat a short distance away was mistaken for a chicken. The color of an old waist appeared so different that she could not recognize the garment for some time after touching it. Except for the color, she would probably have known it at once. She finally made sure by feeling the pin holes in the cuffs and by looking at it with the eye which had not been operated on. The morning after she looked through the university telescope at the stars, she anxiously inquired: 'Could you see any points on the stars?' Her previous touch experience had associated star with a pointed figure. Although her numerous natural blunders in trying to

understand her new experience are exceedingly interesting, they do not seem nearly so remarkable as the marvelous ability she constantly manifested to interpret novel experiences which she knew nothing about previously or knew only by description. The compass, for example, was recognized by sight at once from what she had learned about the magnetic needle, although she had never seen one. All sorts of strangely shaped blocks, complicated pieces of machinery, scenes in the field glass, etc., were accurately described without touch. The fact that so much could be done with the little practice that she had had suggests that too much emphasis ought not to be given to a current theory concerning the non-spread of training. If training is a greatly specialized process, we should expect in Miss W.'s case that the ability to memorize by touch and sound would be markedly better than by sight. When I suggested testing her visual memory, she said at once that she could not remember what she read in print. The preliminary tests which I have been able to carry out, however, indicate that there are only slight differences between auditory, touch and visual memory of a series of letters or of sentences. It is true, no doubt, that the thought to be remembered in all these cases is translated at once into movements of the vocal organs. She repeats to herself what she is reading or hearing. But the fact that visual sensations can be associated so accurately and permanently with the vocal movements of the larynx is still important evidence of the spread of memory training. Unfortunately the tests have not been carried far enough to be conclusive. I can give little more than a general impression. Her reproduction of passages from 'The Greatest Thing in the World,' read by point type, by sound, and by sight was recorded, as was also her memory of twenty letters irregularly arranged and read in the three different ways for several days in succession — until she had committed them all. No weakness of visual memory, or of the translation of visual terms into muscular, if that is the way we remember, was apparent in either of these tests. Further experiments on Miss W. along this line seem to offer a most promising field for educational investigation.

Before the more complete technical description of the experiments and the quantitative results are published, it is desira-

ble that the tests should be repeated on a representative group of normal adults. The conclusions here given are necessarily very guarded because they must depend to a large extent upon impressions gathered from a general survey without adequate opportunity for comparison. In a paper of this length I can only hope to hint at the bearing which the facts discovered have upon various psychological theories. New problems opened up almost daily. The case promises quite as valuable results along other topics of eductional, biological and philosophical importance as those taken up. In the field of psychological æsthetics, naïve preferences were expressed which have interest in connection with primitive conceptions of visual beauty. In the genetic aspect of the case, more work might well be done.[1]

Briefly summarized, the suggestions from a review of this case are: (1) While hearing and touch show great keenness in some respects, there seem to be no records which cannot be explained on the basis of greater interest and training, and without supposing a compensatory change in the capacity of these sense organs. (2) Color vision is so far above normal as to contradict any supposition that 22 years of disuse would cause degeneracy. On the contrary, either the color process deteriorates with use or the removal of the lens and unusual interest produce a remarkable ability to discriminate colors. (3) The reversal of irradiation indicates that a central process may readily outweigh the retinal process. (4) The absence of retinal rivalry suggests that this process is developed by education; and the tendency to regard a single object as double indicates that this is the nature of the first visual experience with two eyes. (5) Contrary to a prevalent opinion, single binocular vision may be acquired, at least temporarily, by an adult born blind. (6) Number and space perceptions are apparently dependent upon movement. (7) An unexpected spread of training, especially in memorizing the visual impressions of printed letters and sentences, suggests a caution as to the amount of training which an intelligent adult may transfer from one field to another.

[1] I desire to express my thanks to Prof. Carl E. Seashore, Mr. Daniel Starch, and Mr. E. A. Jenner. Their suggestions and assistance made it possible to carry out many experiments which could not otherwise have been performed. To Dr. L. W. Dean, also, for his hearty coöperation in the present study.

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